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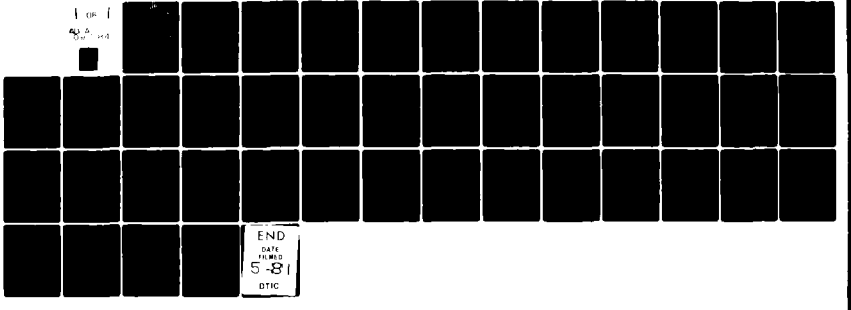

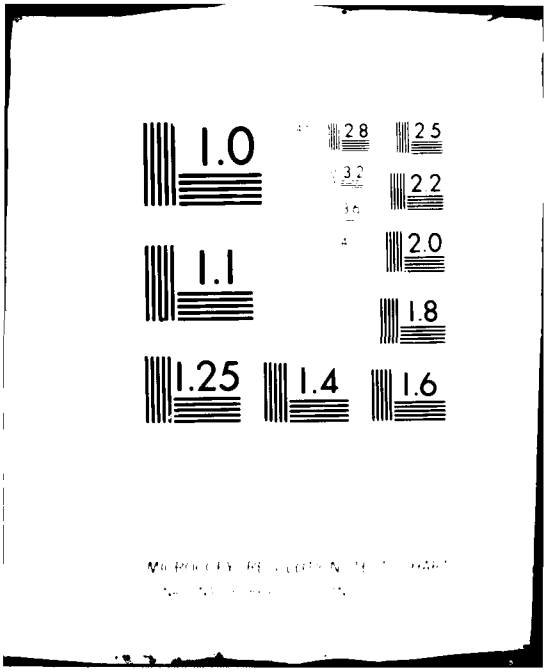
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CASDAC OPERATIONAL ENVIRONMENT STUDY

by

Raymond A. Brengs, Jr.

and

Murle C. Henderson

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David W. Taylor Naval Ship Research and Development Center

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CASDAC OPERATIONAL ENVIRONMENT STUDY

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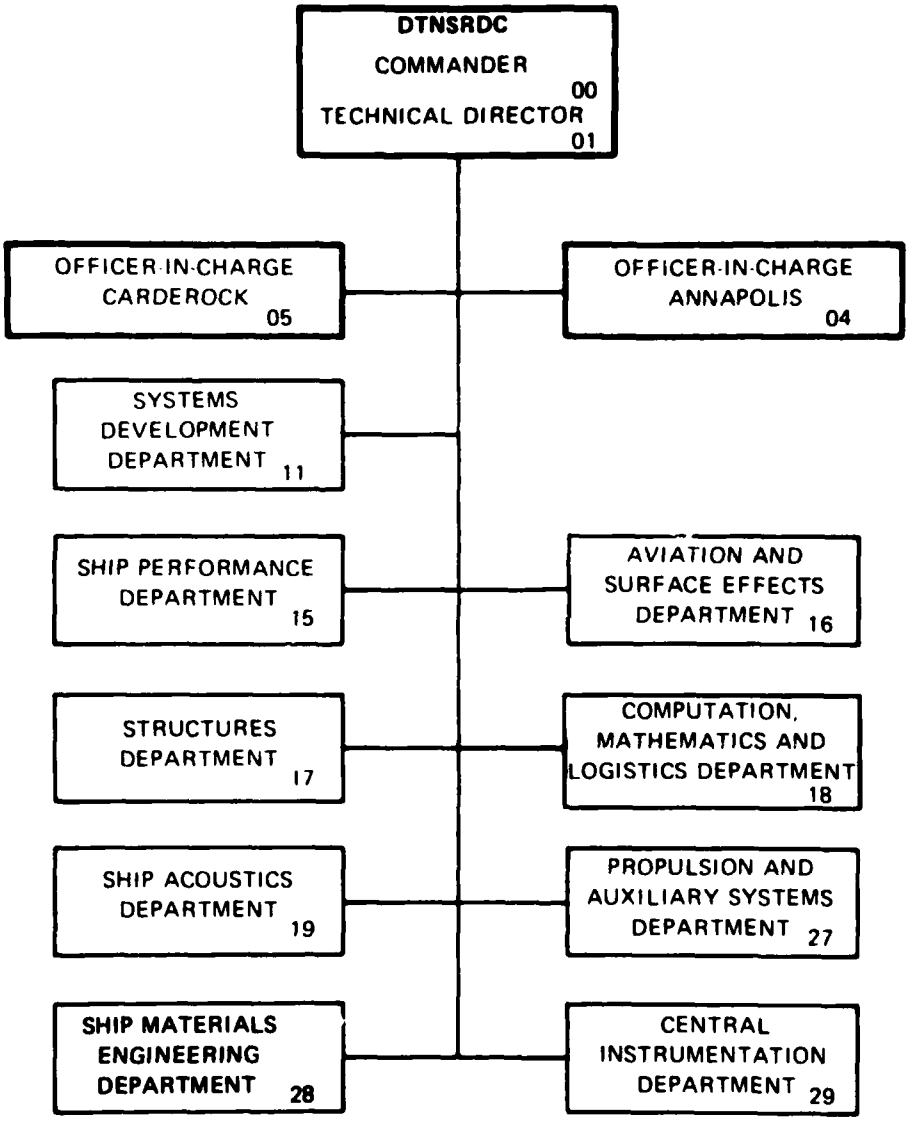

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This report documents a study of the implementation of Computer-Aided Ship Design and Construction (CASDAC) techniques in the Navy and in shipyards building Navy ships. Problems associated with implementation are discussed and several alternative implementation strategies are proposed. These strategies are analyzed for effectiveness in solving implementation problems.

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ABSTRACT

The study defines a number of technical problems associated with the implementation of Computer-Aided Ship Design and Construction (CASDAC) techniques in the Navy and in shipyards building Navy ships. The problems are discussed and alternative implementation strategies are enumerated and an attempt is made at quantitative analysis.

As might have been anticipated, implementation throughout the Navy and Industry using similar computer systems is ranked first and a central system with remote job entry is ranked second.

Practical implementation, however, will additionally involve consultation with the Industry, fiscal considerations and consideration at implementation time of the state of the art in this rapidly developing technology. The merit of the study is in the enumeration of the problems and the projection of their impacts on CASDAC techniques.

ADMINISTRATIVE INFORMATION

Authorization and funding for this work were given under RDT&E element number 62760N, task area SF 53532301, task 14507.

INTRODUCTION AND OBJECTIVES

From the very beginning of the Computer-Aided Ship Design and Construction (CASDAC) project, one important question has continually been raised, "How will CASDAC be implemented in the various shipyards throughout the country?" It has always been recognized that such an undertaking involves many problems, for example, differences in computer hardware/software at the various yards, management or employee attitudes to change, and differences in yard practices (varying methods of construction). Some of the problems and possible solutions have been discussed, but never before has a systematic study documented the problems of shipyard implementation versus the possible alternative environments (that is, implementation strategies). A team of five engineers and one computer scientist, representing all of the various disciplines of the Computer-Aided Design and Manufacturing Division at the David W. Taylor Naval Ship Research and Development Center (DTNSRDC), participated in this study. Four of the six members of the team had experience ranging from two to twenty years in ship design at both Government and private shipyards, and five of the six members had been involved in computer-aided design for at least eight years and were currently involved in the CASDAC program. This report documents the approach, results, and conclusions of the work of this group.

During the first meeting of the study group the objectives of the task were defined and agreed upon. The basic task objective was to narrow the field of possible alternative environments to those which would have the greatest likelihood of success, given all known factors. In other words, the group would determine the most effective operational implementation

strategies (in order of desirability) considering such factors as cost, ease of implementation, interfaces with shipyards, etc. It was recognized from the outset that the group itself was not in a position to make decisions on an implementation strategy but, rather, that the study would set down the problems and suggest an order among the possible solutions.

APPROACH

It has been said that the camel was developed by a committee that was established to design a horse. The obvious moral of this story is that it is difficult to work toward the solution of any problem with five or six individuals who have independent (although knowledgeable) opinions. While this is true, the rewards of group effort are correspondingly very great and can successfully be achieved by any number of proven management techniques. In this case, the group agreed to use a system called "brainstorming."

Brainstorming is, basically, a session in which a knowledgeable group of individuals pours out as many ideas as possible on the subject at hand. Four rules must be adhered to if the session is to be successful. First, judgment must be deferred (criticism comes later). Secondly, there must be a free-wheeling attitude. Flow is important. Third, ideas can be chained. That is, one idea may trigger another idea which is a modification of the first. Duplication should be eliminated afterwards. Fourth, quantity is to be strived for. The flow of the session should produce many ideas. When the flow stops, so should the session. The study group adopted this methodology to develop a list of problems associated with implementation of CASDAC in shipyards and to develop a list of alternative implementation strategies. Once these two lists were obtained, a more complete approach to the study was developed. That approach is as follows:

1. List all problems.
2. Define all problems listed.
3. Categorize the problems.

4. List alternatives.

5. Define the alternatives listed.

6. Show relationship of alternatives to problems (pros and cons).

7. Assign weighting factors to problems (attempt to quantify the problems).

8. Quantify the alternatives.

9. Attempt to draw some conclusions.

The remainder of this report will document the results of and further explain the procedures involved in this approach.

PROCEDURES

LIST, CATEGORIZE, AND DEFINE ALL PROBLEMS

The goal of the first group session was to list every problem the group could conceive which might arise in attempting to implement CASDAC in shipyards (both Government and private). This was done without any preconceived notions about how this implementation would be effected. During this first meeting no corrections or criticisms were permitted nor was any judgment made, such as, for example, that two problems were similar or duplicates. The next several sessions were spent categorizing and defining the problems. During the process of defining the problems it was discovered that, indeed, two or more problems on the list overlapped or were duplicates. Similarly, in categorizing the problems it was found that, in fact, some problems were not problems at all but represented a category of problems which had already been treated at a lower level of detail. Table 1 is a revised list of problems (duplicates having been eliminated). The group found 47 problems significant enough to list separately. These problems were found to fall within six general categories:

1. Government-Wide Problems
2. CASDAC Program Problems
3. Legal Problems
4. Technical (Hardware/Software) Problems
5. Technical Implementation Problems
6. Management/People Problems

Table 2 lists the problems by category and defines each problem. During the definition stage, criticism and discussion were encouraged, since

it was essential to future progress that each member of the group understand and agree with the perception of the problems.

LIST AND DEFINE ALTERNATIVE SOLUTIONS

Having developed a sizeable list of problems, the group next sought implementation solutions. First, alternative implementations were simply listed. Later that list was revised by defining the alternatives and eliminating similar or duplicate approaches. Table 3 represents the final list of 11 alternatives to be examined and an explanation of each.

DEVELOP RELATIONSHIPS BETWEEN ALTERNATIVE ENVIRONMENTS AND THE PROBLEMS OF IMPLEMENTING CASDAC

At this point, the group had a set of problems relating to implementation and had defined 11 possible methods of implementing CASDAC. An obvious question to consider was, "What effect, if any, does a particular implementation strategy have on a given problem?" Each problem was examined in the light of the differing strategies to determine whether it would be solved or reduced by the given strategy, created or increased, or not affected one way or the other. To take a rather obvious example, consider the alternative, "Use of Machine-Portable Code." If the code is truly machine-independent, the problem of "different mainframes" or "different minicomputers" in shipyards completely disappears. However, "implementation ease" is adversely affected due to development problems. It should be equally obvious that the problem of "differences in shipyard design and construction practices" will neither be solved, nor will it be increased. It is a problem that remains unaffected by the particular

solution. As a matter of fact, this particular problem and several others were found to be virtually unaffected by any of the proposed solutions. (See Appendix, page 39.)

Table 4, pages 24 - 34, represents an analysis of the effect of each of the implementation strategies on each of the 47 problems. The effect on a problem is categorized as either reduced, increased, or having no effect. Time and space did not permit documentation of the particular reasoning that was used for each problem categorization.

ASSIGN WEIGHTING FACTORS TO THE PROBLEMS

At this point in the analysis, the group had some useful information as to which alternatives might solve more problems than others. However, the group could not reasonably assume that an implementation which solved more problems than other implementations was necessarily the best solution. All problems could not be considered equally important. Some means was needed to ascribe greater importance to the more severe problems. The method chosen was to assign a quantitative severity factor ranging from 1 to 10 to each problem. The factor was determined by the group's perception of the criticality of the problem.

Each member of the study team was asked to independently assign a grade from 1 to 10 to each problem. Those considered of low importance were to receive a low severity factor; higher scores were reserved for critical problems.

A single severity factor was then obtained by calculating a "modified average," modified in the sense that any singularly very high or low number was ignored. The procedure was as follows:

1. Average the six individual grades obtained, for example:

$$9 + 2 + 6 + 4 + 5 + 4 = 30$$

$$\frac{30}{6} = 5$$

2. If any individual grade is 4 or more units higher or lower than the average, eliminate it and take a new average, for example:

$$. \; . \; . + 2 + 6 + 4 + 5 + 4 = 21$$

$$\frac{21}{5} = 4.2$$

3. If the initial average is within 4 units of each individual grade, retain it, for example:

$$7 + 8 + 9 + 8 + 10 + 10 = 52$$

$$\frac{52}{6} = 8.66$$

Table 5, page 35, is a list of problems arranged in order of decreasing severity.

QUANTIFY THE ALTERNATIVES

At this point the group had a set of problems ranked in order of severity. This enabled a calculation to be performed which resulted in numerical scores for each alternative as it was affected by the problems.

The numerical score for each alternative was calculated as follows (refer to Table 6, page 36):

1. The value +1 was assigned to a problem if it was solved or reduced by a particular alternative; the value -1 was assigned to a problem if a particular alternative created or increased the problem; and the value 0 was assigned to a problem if it did not affect the alternative.

2. For each alternative, the +1, -1, and 0 values were then multiplied by the severity factor of each problem and the sum (numerical score) was calculated and rounded off. For example, the alternative Use Machine-Portable Code (refer to Table 6, page 36, column 1), provided the following calculation):

$$-1(10.00) + 0(9.50) + 1(9.00) + 0(8.80) + 0(8.66)$$

$$+ 1(8.16) + (-1)(7.83)..... + 0(3.00) + 1(3.00) = 31$$

In Table 6, the total scores for each alternative are listed at the bottom of the column representing that alternative (that is, Use Machine-Portable Code scored 31, Use Partially Portable Code scored 41, etc.) These scores, as was mentioned earlier, were obtained using normalized multipliers of +1 for a problem solved, 0 for a problem unchanged, and -1 for a problem negatively affected by the proposed alternative. Since positive multipliers indicated a favorable effect on a problem, the alternatives with the highest scores appear the most likely candidates for succesful implementation.

It was decided that various multipliers should be applied to the problem severity factor in order to determine what effect, if any, would be

evidenced in the relative scores of the various alternatives. Table 7 represents the application of three different multipliers as well as the normalized multipliers to the alternatives. Two of the alternatives clearly stand out from the rest in the analysis. Developing CASDAC on one system and supplying the required hardware as GFE for the ship procurement, and developing CASDAC in a naval shipyard for use in private yards (short term) scored significantly higher regardless of the multipliers used.

Examination of the latter alternative (see Table 3, page 23), shows that this short term solution is only part of a two-phase solution if CASDAC is to be implemented throughout the Industry. The first phase essentially would take advantage of the computer hardware and construction techniques used in the particular Government yard chosen. When re-implementation in private yards is required in phase two, however, the alternative (Develop CASDAC in a naval shipyard (long-term)) does not score well at all.

The single most attractive alternative strategy, then, would be to implement CASDAC on a single set of hardware. This implementation could include any combination of mainframe/host/turnkey systems and peripherals. Once implemented, several such systems could be purchased and provided as Government-furnished equipment (GFE) along with naval construction contracts. In the long run it appears this particular solution would greatly reduce implementation problems caused by differences in hardware, or attempting to develop "machine portable code" and perhaps more importantly would significantly reduce maintenance problems and their associated costs.

CONCLUSIONS

This study was an effort to quantify a problem which is not easily quantified. As such, no attempt should be made to strictly interpret any individual score nor should small relative differences in scores be considered significant. On the other hand, it should be recognized that the final alternative scores were derived from severity values assigned to the problems and that these latter values represent an average of the best estimates of the group.

At some time in the future, a decision will need to be made regarding the implementation strategy for CASDAC. It is hoped that this study will provide a measure of guidance to CASDAC management in that decision-making process. The merit in the report is in the enumeration of the many problems and alternative solutions associated with CASDAC implementation.

Table 1. Problems Associated with CASDAC Implementation

Claims
Funding Instability
Contracting (Red Tape)
ADP Policy (Procurement Problems HW/SW)
Lead Time (Financial Funding)
Portability of Data Base Management System
State of the Art Changing (Computer H/W)
Short Term vs. Long Term Goals
Implementation Ease
Commitment to Hardware/Software (Differences)
Difference in Minicomputers
Integration of Existing Software
Conversion and Overhaul (Different Users and Requirements)
Marketing/Selling CASDAC
Staffing the CASDAC Project
Industry Management Attitudes
Obtaining Authoritative Decisions from Shipyard Managers
Impact on Organizations (Shipyards)
Union (Contracts and Regulations)
Distribution of Vendor Software
Responsiveness to Maintenance Modifications
Maintenance Strategy
Training of Shipyard Personnel
Test and Evaluation
Interface with Other EDP Systems
Integration Strategy
Ensure Development of Maintainable/Readable Programs
Difference in Mainframes
Inconsistent Functional Systems (Dev. Cycle Impl.)
Acceptance of Standards (Engineers vs. Computer)
Credibility of Navy Support
Physical Location of Shipyards
Maintenance Cost
Computer Expertise in Industry
Acceptance of Computer Imposed Standards (Size of Data Field)
Lack of Acceptance of Software (Due to use of Existing Systems)
Lack of Acceptance of Software (Competition from Commercial Systems)
Changing Views (Shipyard)
Navy Management (Higher Level)
Navy Relations with Other Programs
Competition in Shipyards
Uncertainty of Shipyard Support
Unstable Shipyard Economy
Lack of Shipyard Personnel
Personnel Resistance
Difference in Technology Levels Among Different Yards (Non-Computers)
Differences in Yard Practices (Non-Computing)

Table 2. Problems and Definitions, by Category

GOVERNMENT-WIDE PROBLEMS
(THOSE PROBLEMS WHICH ARE GENERAL IN NATURE AND
NOT PECULIAR TO THE CASDAC EFFORT)

CONTRACTING (RED TAPE)	The formal documentation, review, approval, selection, and monitoring process required for awarding a contract to a qualified vendor is cluttered with red tape.
LEAD TIME	Full funds must be available in order to award a contract and yet the funding level is announced too late and is usually incrementally divided so as not to provide full funds.
ADP POLICY	There are fewer clear procedures to follow in the procurement of ADP hardware/software compared to those which exist in military hardware procurement. Because of the proliferation of ADP systems throughout the Government, agencies have been established to scrutinize carefully each ADP procurement. While this is not bad in itself, it often unduly complicates simple procurement of peripheral devices or small minicomputer systems and adds an additional layer to the Government procurement cycle.
UNSTABLE SHIPYARD ECONOMY	Funding for new ship construction has not only been decreasing, but is also uncertain. Congress has often seen fit to "cut" certain ships or ship systems from the budget. The shipyards are reluctant to make significant investments in capital improvements (including computer systems or new computer aids) in the light of this environment.
CASDAC PROGRAM DIFFICULTIES (THOSE PROBLEMS RELATED SPECIFICALLY TO OUR PROJECT)	
STAFFING THE CASDAC PROJECT	It is difficult to hire personnel with both the proper foundation in ship design and construction and sufficient knowledge of computer techniques. This problem is further aggraveted by ceiling restrictions on numbers of personnel as well as average grade level. Qualified ship design personnel cannot be hired at the entry level.
MARKETING/SELLING CASDAC	It is difficult to sell shipyard management on the CASDAC project when the Navy has consistently been unable to provide adequate and stable financial support. Funding problems, coupled with all other problems (including lack of incentive), has not encouraged shipyard support of CASDAC.
NAVY RELATIONS WITH OTHER PROGRAMS	While the Navy has followed with interest the developments in computer technology by NASA, the Air Force, REAPS, ASME, AUTOKON, etc., funds have never been available to participate in these projects in more than observer status.

Table 2. (Cont'd)

CASDAC PROGRAM DIFFICULTIES (Cont'd.)	
CREDIBILITY OF NAVY SUPPORT	While top Navy management has repeatedly praised CASDAC as a worthwhile program, the source of funding has never been clear. As a result, the funding has been inadequate for proper execution of the project.
NAVY MANAGEMENT (HIGHER LEVEL)	The goals of CASDAC (both short- and long-term) have been shifted to suit desires of current sponsors.
INCONSISTENT FUNCTIONAL SYSTEMS	Development of the Piping/Machinery/Electrical/Hull systems has not been parallel, due to insufficient funding. In addition, existing software packages are available in each functional system which should be used to avoid duplication of effort. These packages are not compatible or consistent with each other and may lead to sub-optimization.
FUNDING INSTABILITY	Funding sources and levels have not been steady enough to permit adequate or effective planning.
LEGAL PROBLEMS	
UNION (CONTRACTS AND REGULATIONS)	Many shipyards have unions for professional employees as well as craftsmen. The rules and regulations of these unions may conflict with changes required to implement a successful CASDAC system.
DISTRIBUTION OF VENDOR SOFTWARE	Many existing systems which could be used by CASDAC are proprietary. This creates a problem in distributing the software outside the Navy (to private shipyards).
CLAIMS	The Navy is already facing a serious problem with claims from shipyards. If a shipyard uses CASDAC and experiences initial implementation difficulties, additional claims could be generated. CASDAC must be implemented in a manner which reduces or eliminates additional claims and perhaps reduces some existing causes for claims.
TECHNICAL HARDWARE/SOFTWARE PROBLEMS (THOSE NON-POLITICAL (THAT IS, TECHNICAL) PROBLEMS ASSOCIATED WITH CASDAC IMPLEMENTATION)	
PORTABILITY OF DATA BASE MANAGEMENT SYSTEM	If CASDAC is to be developed on more than one machine, difficulties will be experienced in handling the large amounts of data required. While portability of programs can be obtained by using languages such as FORTRAN, standardization of data base management is a more difficult problem.

Table 2. (Cont'd.)

TECHNICAL HARDWARE/SOFTWARE PROBLEMS (Cont'd.)	
ENSURE DEVELOPMENT OF MAINTAINABILITY/ READABLE PROGRAMS	Computer program changes are inevitable. With this fact in mind, programmers must write them so they are both readable and maintainable. While specifications for program development can include many guidelines for increasing maintainability, there are many other related problems such as proper documentation, differences of hardware and software, and providing adequate resources for program maintenance.
INTEGRATION OF EXISTING SOFTWARE	While software exists to perform some of the tasks required in the CASDAC functional systems (HULDAC, CAPDAC, ELXDAC), it is incomplete. If this software is to be used within CASDAC, the additional functions required will have to be "programmed around" the existing software. This problem is related to inconsistent functional systems, since each system has different existing software to "program around."
INTERFACE WITH OTHER EDP SYSTEMS	Some existing software which would be useful within CASDAC is machine- or device-dependent. If this software is to be utilized, either it will have to be modified to suit other hardware or the required hardware/devices will have to be integrated within the overall CASDAC hardware/software configuration.
DIFFERENCE IN MAINFRAMES	Most shipyards have "mainframe" computers and a certain degree (more or less) of commitment to that hardware. If some allowance is given to the fact that existing hardware will be utilized, technical problems exist in providing "portable" and maintainable CASDAC programs. These problems include differences in operating systems, word size, off-line storage, etc.
DIFFERENCE IN MINICOMPUTERS	This problem is similar to the problem of differences in mainframes, except that it is even more likely that the shipyards which have existing minicomputer and/or graphics systems will be committed to them.
STATE OF THE ART CHANGING (COMPUTER HARDWARE)	Computer hardware (and also software) is in a state of constant evolution. If CASDAC decides on a particular set of hardware/software, for any reason, new advances will tend to make CASDAC obsolete or, at least, less efficient. Even if CASDAC is developed as "machine portable" now, new advances may destroy that portability.
TECHNICAL IMPLEMENTATION PROBLEMS (GENERAL)	
PHYSICAL LOCATION OF SHIPYARDS	Since shipyards are spread throughout the country (from coast to coast) other problems, such as implementation and maintenance, are increased. The severity of this problem, like others, varies with the solution chosen.

Table 2. (Cont'd.)

TECHNICAL IMPLEMENTATION PROBLEMS (Cont'd.)	
DIFFERENCES IN YARD PRACTICES (NON-COMPUTING)	It will be difficult to develop standard computer-aided tools for shipyards since their methods vary on such things as the size of construction modules handled at the yard, the methods of equipment installation, and design practices. Even the number of characters in a plan number can create problems for a standard computer program.
DIFFERENCE IN TECHNOLOGY LEVELS AMONG DIFFERENT YARDS (NON-COMPUTING)	The various yards are at different levels with regard to transfer of technology. Most yards, for example, employ automation to some extent. The degree of automation varies widely, however.
CONVERSION AND OVERHAUL (DIFFERENT USERS AND REQUIREMENTS)	The conversion and overhaul process is not necessarily the same as the new construction process. For example, in new construction design, plans are developed from scratch or from modifying old plans. In conversion and overhaul some means of describing "rip-out" requirements are just as important as describing installation requirements. Also, conversion and overhaul can be performed in naval shipyards as well as private shipyards. This will create long-term problems if CASDAC development and implementation are aimed only at private yards.
SHORT-TERM VERSUS LONG-TERM GOALS	Strong concentration on short-term goals, such as immediate payoff, may result in sub-optimization and reduce or eliminate long-term payoffs from such things as integration.
INTEGRATION STRATEGY	There are many problems associated with integration strategy, including how to integrate existing software packages, what level of integration should be achieved, whether there should be a central, integrated data base, etc.
MAINTENANCE STRATEGY	How will programs be maintained? Will shipyards maintain programs or should this be the responsibility of one central maintenance group? How will maintenance be performed if separate "implementations" are permitted on different hardware?, etc.
MAINTENANCE COST	The cost of maintenance is always much larger than originally thought. In addition, whereas program development costs come to an end, maintenance costs go virtually forever. Another consideration is that sponsors often overlook the need to program maintenance costs into the budget
RESPONSIVENESS TO MAINTENANCE MODIFICATIONS	If CASDAC is to be successful, program "bugs" or changes must be implemented rapidly. CASDAC modifications must not be permitted to impede the design/construction process or CASDAC will not be accepted as a viable tool. In addition, the Navy will be the target of valid claims on the part of shipbuilders unless responsiveness to modifications is immediate and accurate.

Table 2. (Cont'd)

TECHNICAL IMPLEMENTATION PROBLEMS (Cont'd.)	
TEST AND EVALUATION	When programs are developed, a test and evaluation (T&E) plan must be developed so that programs can be "benchmarked." The T&E plan tells the program developer what is expected of the program and also provides for testing prior to production running. We can not permit untested programs to be delivered to shipyards for production use.
TRAINING OF SHIPYARD PERSONNEL	Shipyard personnel will need to be trained in the use of CASDAC computer programs. The training program will need to both formal and continuing. Since most shipyard personnel have little or no knowledge of computers, training will need to be comprehensive.
IMPLEMENTATION EASE	Implementation of CASDAC will be a serious problem. The ease or difficulty of implementation will vary considerably with the particular implementation alternative chosen.
MANAGEMENT/PEOPLE/STAFF PROBLEMS	
COMPUTER EXPERTISE IN INDUSTRY	Designers and draftsmen as well as engineers, will need to have some computer knowledge to implement CASDAC. In most shipyards, computer knowledge is not common among the designers or draftsmen.
IMPACT ON ORGANIZATIONS (SHIPYARDS)	CASDAC implementation may cause a reorganization in some shipyards. In many shipyards, designers and draftsmen are not in the same department as engineers and computer scientists. A merging of the four disciplines may be necessary. Also, a seperate computer-related department may be necessary.
LACK OF ACCEPTANCE OF SOFTWARE (DUE TO USE OF EXISTING SYSTEMS)	Shipyards with existing computer programs for ship design and construction may be reluctant to share these programs with other shipyards or to accept similar programs. Also, present software may not be compatible with existing systems in the shipyards.
LACK OF ACCEPTANCE OF SOFTWARE (COMPETITION FROM COMMERCIAL SYSTEMS)	Shipyards may choose to implement a "turnkey" commercial system rather than some program or system which CASDAC may offer.
PERSONNEL RESISTANCE	Many blue-collar workers balk at the use of computer methods for fear of a reduction in the work force. Also, personnel have a tendency to resist change. Many workers have the attitude that "It has worked well for the last 100 years. Why change?"
INDUSTRY MANAGEMENT ATTITUDES	Top level shipyard management support is essential if the potential economic benefits of computer technology are to be realized.

Table 2. *(Cont'd.)*

MANAGEMENT/PEOPLE/STAFF PROBLEMS (Cont'd.)	
COMMITMENT TO HARDWARE/SOFTWARE (DIFFERENCES)	Many shipyards believe they are committed to their present hardware/software configurations and would be reluctant to change in order to be compatible with other shipyards.
ACCEPTANCE OF STANDARDS (ENGINEERING VERSUS COMPUTER)	Inherent in acceptance of CASDAC programs will be acceptance of the engineering algorithms and standards which are built into the programs. While many engineering standards are imposed by military specifications, there are other standards which are optional and which differ from yard to yard.
COMPETITION IN SHIPYARDS	Many shipyards believe they have a competitive edge over other shipyards and would be be reluctant to accept any means of equalization.
LACK OF SHIPYARD PERSONNEL	The shipyard employee population is very variable as it reflects new design and construction awards which come in waves ("feast or famine" effects).
UNCERTAINTY OF SHIPYARD SUPPORT	Due to the feast or famine nature of the shipbuilding business long range business forecasting is difficult and support for projects with a two or three year initial development time is uncertain.
OBTAINING AUTHORITATIVE DECISIONS FROM SHIPYARD MANAGERS	It is difficult to obtain decisions from shipyard managers on CASDAC-related matters because of the uncertainty of the project.
CHANGING VIEWS (SHIPYARD)	Shipyard managers, of necessity, have flexible policies regarding the type of work sought and, to date, CASDAC development is clouded with uncertainties.
ACCEPTANCE OF COMPUTER-IMPOSED STANDARDS	Shipyards are reluctant to accept computer-imposed standards, especially if these standards will change existing software formats. Other computer-imposed standards are in conflict with manual methods. One example of this is the number of digits allowed in a plan number.

Table 3. Alternative Implementation Strategies

USE OF MACHINE-PORTABLE CODE	Programs and data bases would be developed in such a manner as to make them operable on any computer system. This does not mean that no rework would be required to convert from machine to machine, but simply that this effort would be minimal.
USE OF PARTIALLY PORTABLE CODE (SPECIFIC MACHINES)	As in the above approach, programs would be written to operate on more than one machine. In this case, however, the target machine would be limited to the major computer systems currently installed in the various shipyards.
DEVELOP CASDAC ON ONE SYSTEM (RJE TIE-IN)	In this implementation, one specific manufacturer's computer system would be selected for CASDAC development and CASDAC would be developed in such a manner as to allow shipyards to operate programs remotely with low-cost terminals. This alternative would also allow a shipyard to utilize its own machine (or a locally available machine) provided that it was of the same type (manufacturer and series).
DEVELOP CASDAC ON A A CENTRAL SYSTEM (RJE TIE-IN)	This approach would likewise provide access to CASDAC software via inexpensive terminals but would require the user to access a single, Navy-supported central computer. All programs and ship's data would reside at that central site.
DEVELOP CASDAC ON ONE SYSTEM (BUY MACHINE FOR YARDS)	This implementation would involve selecting a particular type of computer and developing all programs for only that system. Full advantage would be made of all hardware/software features. One or more of these complete systems would be purchased and would be provided to shipyards/contractors for design of Navy ships.
DEVELOP CASDAC ON ONE SYSTEM (REQUIRE SHIPYARDS TO BUY MACHINES)	This is similar to the above approach except that the Navy would not provide the required hardware. Only CASDAC software would be made available.
DEVELOP (CONVERT) PROGRAMS TO TWO OR MORE SYSTEMS	This alternative may at first appear to be the same approach as using portable code, but it is not. Programs would be specifically written for two or more given machines. Several versions of the same program might exist for each of the several machines and full capabilities of each machine could be utilized.
DEVELOP CASDAC ON A COMMERCIALLY AVAILABLE NETWORK (NON-HOMOGENEOUS)	This approach would permit shipyards to tie into a network on which CASDAC software would be available. Since the network would be non-homogenous, CASDAC programs not only could be dispersed on various computers, but could be implemented on various types and sizes of computers.

Table 3. (Cont'd.)

DEVELOP CASDAC ON A COMMERCIALLY AVAILABLE NETWORK (HOMOGENEOUS)	Networking is also the key to this approach. However, in this case, all computers would be of the same type.
DEVELOP CASDAC IN A NAVAL SHIPYARD FOR FUTURE USE IN PRIVATE YARDS (LONG TERM)	This approach and the approach that follows are basically the same two-phased implementation. The first phase would be to select a Government shipyard in which to implement and prove the effectiveness of CASDAC. Phase two would then consist of "re-implementing" CASDAC at private yards desiring the system. Obviously, many problems would be solved in phase 1 only to reappear in phase 2, and thus both the long and short terms of this approach were analyzed.
DEVELOP CASDAC IN A NAVAL SHIPYARD FOR FUTURE USE IN PRIVATE YARDS (SHORT TERM)	This is the same as the above, except that phase 1 is analyzed separately (that is, no concern is given to "re-implementing" CASDAC in private yards).

Table 4. Analysis of Effects of Strategies on Problems

ALTERNATIVE	PROBLEMS		
	SOLVED OR REDUCED	CREATED OR INCREASED	UNAFFECTED
Use machine portable code	Physical Location of Shipyards Obtaining Authoritative Decisions from Shipyard Managers State of the Art Changing (Computer H/W) Computer Expertise in Industry Marketing/Selling CASDAC Difference in Mainframes Difference in Minicomputers Commitment to Hardware/Software (Differences) Industry Management Attitudes Lack of Acceptance of Software (Due to Use of Existing Systems) Uncertainty of Shipyard Support Impact on Organizations (Shipyards) Conversion and Overhaul (Different Users and Requirements)	Implementation Ease Claims Contracting (Red Tape) Maintenance Cost Maintenance Strategy Test and Evaluation Responsiveness to Maintenance Modifications Staffing the CASDAC Project	Acceptance of Computer Imposed Standards (Size of Data Field) Lack of Acceptance of Software (Competition from Commercial Systems) Competition in Shipyards Inconsistent Functional Systems (Dev. Cycle and Impl.) Short Term vs. Long Term Goals Training of Shipyard Personnel Integration of Existing Software Portability of Data Base Management System Changing Views (Shipyard) Funding Instability Lead Time (Financial Funding) Credibility of Navy Support Lack of Shipyard Personnel Unstable Shipyard Economy Navy Management (Higher Level) Navy Relations with Other Programs ADP Policy (Procurement Problems HW/SW) Ensure Development of Maintainable/Readable Programs Acceptance of Standards (Engineering vs. Computer) Union (Contracts and Regulations) Personnel Resistance Integration Strategy Differences in Yard Practices (Non-Computing) Distribution of Vendor Software Interface with Other EDP Systems Difference in Technology Levels Among Different Yards (Non-Computers)

Table 4. (Cont'd.)

ALTERNATIVE	PROBLEMS		
	SOLVED OR REDUCED	CREATED OR INCREASED	UNAFFECTED
Use Partially Portable Code (Specific Machines)	Physical Location of Shipyards Uncertainty of Shipyard Support Inconsistent Functional Systems (Dev. Cycle and Impl.) Interface with Other EDP Systems Marketing/Selling CASDAC Obtaining Authoritative Decisions from Shipyard Managers Difference in Mainframes Commitment to Hardware/Software (Differences) Industry Management Attitudes Lack of Acceptance of Software (Due to Use of Existing Systems) Impact on Organizations (Shipyards) Maintenance Cost Maintenance Strategy Conversion and Overhaul (Different Users and Requirements) Responsiveness to Maintenance Modifications Credibility of Navy Support	Implementation Ease State of the Art Changing (Computer H/W) Contracting (Red Tape) Integration of Existing Software Claims Staffing the CASDAC Project Lead Time (Financial Funding)	Competition in Shipyards Acceptance of Computer Imposed Standards (Size of Data Field) Lack of Acceptance of Software (Competition from Commercial Systems) Ensure Development of Maintainable/Readable Programs Acceptance of Standards (Engineering vs. Computer) Difference in Minicomputers Personnel Resistance Union (Contracts and Regulations) Integration Strategy Test and Evaluation Training of Shipyard Personnel Differences in Yard Practices (Non-Computing) Distribution of Vendor Software Difference in Technology Levels Among Different Yards (Non-Computers) Computer Expertise in Industry Portability of Data Base Management System Changing Views (Shipyard) Funding Instability Short Term vs. Long Term Goals Lack of Shipyard Personnel Unstable Shipyard Economy Navy Management (Higher Level) Navy Relations with Other Programs ADP Policy (Procurement Problems HW/SW)

Table 4. (Cont'd.)

ALTERNATIVE	PROBLEMS		
	SOLVED OR REDUCED	CREATED OR INCREASED	UNAFFECTED
Develop CASDAC on One System (RJE Tie-In)	Implementation Ease Physical Location of Shipyards Computer Expertise in Industry Portability of Data Base Management System Contracting (Red Tape) Lead Time (Financial Funding) Inconsistent Functional Systems (Dev. Cycle and Impl.) Marketing/Selling CASDAC Difference in Mainframes Claims Lack of Acceptance of Software (Due to Use of Existing Systems) Integration Strategy Maintenance Cost Maintenance Stategy Test and Evaluation Training of Shipyard Personnel Conversion and Overhaul (Different Users and Requirements) Distribution of Vendor Software Responsiveness to Maintenance Modifications	State of the Art Changing (Computer HW) ADP Policy (Procurement Problems HW/SW) Integration of Existing Software Interface with Other EDP Systems Ensure Development of Maintainable/Readable Programs Commitment to Hardware/Software (Differences) Impact on Organizations (Shipyards)	Acceptance of Computer Imposed Standards (Size of Data Field) Lack of Acceptance of Software (Competition from Commercial Systems) Changing Views (Shipyards) Obtaining Authoritative Decisions from Shipyard Managers Staffing the CASDAC Project Funding Instability Short Term vs. Long Term Goals Credibility of Navy Support Uncertainty of Shipyard Support Lack of Shipyard Personnel Unstable Shipyard Economy Navy Management (Higher Level) Navy Relations with Other Programs Competition in Shipyards Acceptance of Standards (Engineering vs. Computer) Difference in Minicomputers Industry Management Attitudes Personnel Resistance Union (Contracts and Regulations) Differences in Yard Practices (Non-Computing) Difference in Technology Levels Among Different Yards (Non-Computers)

Table 4. (Cont'd.)

ALTERNATIVE	PROBLEMS		
	SOLVED OR REDUCED	CREATED OR INCREASED	UNAFFECTED
Develop CASDAC On Central System (RJE Tie-In)	Implementation Ease Responsiveness to Maintenance Modifications Distribution of Vendor Software Conversion and Overhaul (Different Users and Requirements) Training of Shipyard Personnel Test and Evaluation Maintenance Cost Maintenance Strategy Integration Strategy Lack of Acceptance of Software (Due to Use of Existing Systems) Claims Difference in Mainframes Marketing/Selling CASDAC Inconsistent Functional Systems (Dev Cycle and Impl.) Lead Time (Financial Funding) Contracting (Red Tape) Portability of Data Base Management System Computer Expertise in Industry Physical Location of Shipyards	Impact on Organizations (Shipyards) Commitment to Hardware/Software (Differences) Ensure Development of Maintainable/Readable Programs Interface with Other EDP Systems Integration of Existing Software ADP Policy (Procurement Problems HW/SW) State of the Art Changing (Computer H/W)	Acceptance of Computer Imposed Standards (Size of Data Field) Lack of Acceptance of Software (Competition from Commercial Systems) Changing Views (Shipyard) Obtaining Authoritative Decisions from Shipyard Managers Staffing the CASDAC Project Funding Instability Short Term vs. Long Term Goals Credibility of Navy Support Uncertainty of Shipyard Support Lack of Shipyard Personnel Unstable Shipyard Economy Navy Management (Higher Level) Navy Relations with Other Programs Competition in Shipyards Acceptance of Standards (Engineering vs Computer) Difference in Minicomputers Industry Management Attitudes Personnel Resistance Union (Contracts and Regulations) Differences in Yard Practices (Non Computing) Difference in Technology Levels Among Different Yards (Non Computers)

Table 4. (Cont'd.)

ALTERNATIVE	PROBLEMS		
	SOLVED OR REDUCED	CREATED OR INCREASED	UNAFFECTED
Develop CASDAC On One System (Buy Machines for Shipyards)	Implementation Ease Acceptance of Computer Imposed Standards (Size of Data Field) Lack of Acceptance of Software (Competition from Commercial Systems) Physical Location of Shipyards Computer Expertise in Industry Portability of Data Base Management System Obtaining Authoritative Decisions from Shipyard Managers Staffing the CASDAC Project Contracting (Red Tape) Lead Time (Financial Funding) Credibility of Navy Support Uncertainty of Shipyard Support Inconsistent Functional Systems (Dev. Cycle and Impl.) Interface with Other EDP Systems Ensure Development of Maintainable/Readable Programs Marketing/Selling CASDAC Difference in Mainframes Industry Management Attitudes Claims Lack of Acceptance of Software (Due to Use of Existing Systems) Integration Strategy Maintenance Cost Maintenance Strategy Test and Evaluation Training of Shipyard Personnel Conversion and Overhaul (Different Users and Requirements) Distribution of Vendor Software	State of the Art Changing (Computer H/W) ADP Policy (Procurement Problems H/W) Integration of Existing Software Commitment to Hardware/Software (Differences)	Changing Views (Shipyard) Funding Instability Short Term vs. Long Term Goals Lack of Shipyard Personnel Unstable Shipyard Economy Navy Management (Higher Level) Navy Relations with Other Programs Competition in Shipyards Acceptance of Standards (Engineering vs. Computer) Difference in Minicomputers Personnel Resistance Union (Contracts and Regulations) Impact on Organizations (Shipyards) Differences in Yard Practices (Non-Computing) Difference in Technology Levels Among Different Yards (Non-Computers)

Table 4. (Cont'd.)

ALTERNATIVE	PROBLEMS		
	SOLVED OR REDUCED	CREATED OR INCREASED	UNAFFECTED
Develop CASDAC on One System (Buy Machines for Shipyards) (Cont'd)	Responsiveness to Maintenance Modifications		
Develop CASDAC On One System (Require Shipyards to Buy Machines)	Implementation Ease Physical Location of Shipyards Portability of Data Base Management System Staffing the CASDAC Project Contracting (Red Tape) Lead Time (Financial Funding) Credibility of Navy Support Inconsistent Functional Systems (Dev. Cycle Impl.) Integration of Existing Software Interface with Other EDP Systems Ensure Development of Maintainable/Readable Programs Difference in Mainframes Lack of Acceptance of Software (Due to Use of Existing Systems) Integration Strategy Maintenance Cost Maintenance Strategy Test and Evaluation Training of Shipyard Personnel Conversion and Overhaul (Different Users and Requirements) Responsiveness to Maintenance Modifications	Obtaining Authoritative Decisions from Shipyard Managers Impact on Organizations (Shipyards) Computer Expertise in Industry State of the Art Changing (Computer HW) Uncertainty of Shipyard Support Lack of Shipyard Personnel Marketing/Selling CASDAC Commitment to Hardware/Software (Differences) Industry Management Attitudes Claims Distribution of Vendor Software	Acceptance of Computer Imposed Standards (Size of Data Field) Lack of Acceptance of Software (Competition from Commercial Systems) Changing Views (Shipyard) Funding Instability Short Term vs. Long Term Goals Unstable Shipyard Economy Navy Management (Higher Level) Navy Relations with Other Programs ADP Policy (Procurement Problems HW/SW) Competition in Shipyards Acceptance of Standards (Engineering vs. Computer) Difference In Minicomputers Personnel Resistance Union (Contracts and Regulations) Differences in Yard Practices (Non-Computing) Difference in Technology Levels Among Different Yards (Non-Computers)

Table 4. (Cont'd.)

ALTERNATIVE	PROBLEMS		
	SOLVED OR REDUCED	CREATED OR INCREASED	UNAFFECTED
Develop (Convert) Programs to Two or More Systems	Implementation Ease Physical Location of Shipyards Computer Expertise in Industry Obtaining Authoritative Decisions from Shipyard Managers Credibility of Navy Support Uncertainty of Shipyard Support ADP Policy (Procurement Problems HW/SW) Marketing/Selling CASDAC Difference in Mainframes Commitment to Hardware/Software (Differences) Industry Management Attitudes Lack of Acceptance of Software (Due to Use of Existing Systems) Impact on Organizations (Shipyards) Conversion and Overhaul (Different Users and Requirements)	Portability of Data Base Management System State of the Art Changing (Computer H/W) Staffing the CASDAC Project Contracting (Red Tape) Lead Time (Financial Funding) Inconsistent Functional System (Dev. Cycle and Impl.) Integration of Existing Software Interface with Other EDP Systems Ensure Development of Maintainable/Readable Programs Difference in Minicomputers Claims Integration Strategy Test and Evaluation Training of Shipyard Personnel Distribution of Vendor Software Maintenance Cost Maintenance Strategy Responsiveness to Maintenance Modifications	Acceptance of Computer Imposed Standards (Size of Data Field) Lack of Acceptance of Software (Competition from Commercial Systems) Union (Contracts and Regulations) Personnel Resistance Acceptance of Standards (Engineering vs. Computer) Competition in Shipyards Navy Relations with Other Programs Navy Management (Higher Level Unstable Shipyard Economy Lack of Shipyard Personnel Short Term vs. Long Term Goals Funding Instability Changing Views (Shipyard) Differences in Yard Practices (Non-Computing) Difference in Technology Levels Among Different Yards (Non-Computers)
Develop CASDAC On	Marketing/Selling CASDAC Physical Location of Shipyards Obtaining Authoritative Decisions from Shipyard Managers State of the Art Changing (Computer H/W) Credibility of Navy Support Uncertainty of Shipyard Support Integration of Existing Software Interface with Other EDP Systems Difference in Mainframes Difference in Minicomputers Commitment to	Implementation Ease Competition in Shipyards Computer Expertise in Industry Portability of Data Base Management System Staffing the CASDAC Project Contracting (Red-Tape) Lead Time (Financial Funding) Claims Maintenance Cost Maintenance Strategy Test and Evaluation	Acceptance of Computer Imposed Standards (Size of Data Field) Lack of Acceptance of Software (Competition from Commercial Systems) Changing Views (Shipyard) Funding Instability Short Term vs. Long Term Goals Lack of Shipyard Personnel Unstable Shipyard Economy Inconsistent Functional Systems (Dev Cycle Impl.) Navy Management (Higher Level)

Table 4. (Cont'd.)

ALTERNATIVE	PROBLEMS		
	SOLVED OR REDUCED	CREATED OR INCREASED	UNAFFECTED
Develop CASDAC ON Commercially Available Network (Non Homogenous) Cont'd	Hardware Software (Differences) Industry Management Attitudes Lack of Acceptance of Software (Due to Use of Existing Systems) Impact on Organizations (Shipyards) Conversion and Overhaul (Different Users and Requirements)	Responsiveness to Maintenance Modifications	Navy Relations with Other Programs ADP Policy (Procurement Problems HW SW) Ensure Development of Maintainable/Readable Programs Acceptance of Standards (Engineers vs Computer) Personnel Resistance Union (Contracts and Regulations) Integration Strategy Training of Shipyard Personnel Differences in Yard Practices (Non-Computing) Distribution of Vendor Software Difference in Technology Levels Among Different Yards (Non Computers)
Develop CASDAC On Commercially Available Network (Homogeneous)	Implementation Ease Marketing Selling CASDAC Physical Location of Shipyards Portability of Data Base Management System Staffing the CASDAC Project Lead Time (Financial Funding Credibility of Navy Support Uncertainty of Shipyard Support Industry Management Attitudes Lack of Acceptance of Software (Due to Use of Existing Systems) Maintenance Cost Maintenance Strategy Test and Evaluation Training of Shipyard Personnel Responsiveness to Maintenance Modifications	State of the Art Changing (Computer H/W) Contracting (Red Tape) Integration of Existing Software Interface with Other EDP Systems Difference in Mainframes Difference in Minicomputers Commitment to Hardware Software (Differences Claims Impact on Organizations Shipyards	Acceptance of Computer Imposed Standards (Size of Data Field) Lack of Acceptance of Software (Competition from Commercial Systems) Competition in Shipyards Computer Expertise in Industry Changing Views (Shipyard) Obtaining Authoritative Decisions from Shipyard Managers Funding Instability Short Term vs Long Term Goals Lack of Shipyard Personnel Unstable Shipyard Economy Inconsistent Functional Systems (Dev Cycle and Impl.) Navy Management (Higher Level) Navy Relations with Other Programs

Table 4. (Cont'd.)

ALTERNATIVE	PROBLEMS		
		CREATED OR INCREASED	UNAFFECTED
Develop CASDAC On Commercially Available Network (Homogeneous) Cont'd			ADP Policy (Procurement Problems HW/SW). Ensure Development of Maintainable/Readable Programs Acceptance of Standards (Engineering vs. Computer) Personnel Resistance Union (Contracts and Regulations) Integration Strategy Differences in Yard Practices (Non-Computing) Conversion and Overhaul (Different Users and Requirements) Distribution of Vendor Software Difference in Technology Levels Among Different Yards (Non-Computers)
Develop CASDAC In a Naval Shipyard for Future Use in Private Yards (Long Term)	Test and Evaluation Obtaining Authoritative Decisions from Shipyard Managers Industry Management Attitudes Marketing Selling CASDAC Uncertainty of Shipyard Support Implementation Ease Credibility of Navy Support Conversion and Overhaul (Different Users and Requirements) Claims Navy Relations with Other Programs	State of the Art Changing (Computer H/W) Integration of Existing Software	Training of Shipyard Personnel Staffing the CASDAC Project Responsiveness to Maintenance Modifications Portability of Data Base Management System Physical Location of Shipyards Maintenance Strategy Maintenance Cost Computer Expertise in Industry Lead Time (Financial Funding) Lack of Shipyard Personnel Lack of Acceptance of Software (Due to Use of Existing Systems) Lack of Acceptance of Software (Competition from Commercial Systems) Interface with Other EDP Systems Integration Strategy Inconsistent Functional Systems (Dev. Cycle and Impl.)

Table 4. (Cont'd.)

ALTERNATIVE	PROBLEMS		
	SOLVED OR REDUCED	CREATED OR INCREASED	UNAFFECTED
Develop CASDAC in a Naval Shipyard for Future Use in Private Yards (Long Term) Cont'd			Impact on Organizations (Shipyards) Ensure Development of Maintainable/Readable Programs Distribution of Vendor Software Difference in Minicomputers Difference in Mainframes Contracting (Red Tape) Commitment to Hardware/Software (Differences) ADP Policy (Procurement Problems HW/SW) Navy Management (Higher Level) Short Term vs. Long Term Goals Funding Instability Changing Views (Shipyard) Union (Contracts and Regulations) Competition in Shipyards Unstable Shipyard Economy Difference in Technology Levels Among Different Yards (Non-Computers) Differences in Yard Practices (Non-Computing) Personnel Resistance Acceptance of Standards (Engineering vs. Computer) Acceptance of Computer Imposed Standards (Size of Data Field)
Develop CASDAC in a Naval Shipyard for Future Use in Private Yards (Short Term)	Unstable Shipyard Economy Union (Contracts and Regulations) Training of Shipyard Personnel Test and Evaluation Responsiveness to Maintanance Modifications Physical Location of Shipyards Navy Relations with Other Programs	Short Term vs. Long Term Goals	State of the Art Changing (Computer H/W) Staffing the CASDAC Project Portability of Data Base Management System Personnel Resistance Navy Management (Higher Level) Lead Time (Financial Funding) Interface with Other EDP Systems

Table 4. (Cont'd.)

ALTERNATIVE	PROBLEMS		
	SOLVED OR REDUCED	CREATED OR INCREASED	UNAFFECTED
Develop CASDAC in a Naval Shipyard for Future Use in Private Yards (Short Term) Cont'd	Obtaining Authoritative Decisions from Shipyard Managers Marketing/Selling CASDAC Industry Management Attitudes Maintenance Strategy Maintenance Cost Computer Expertise in Industry Lack of Shipyard Personnel Uncertainty of Shipyard Support Lack of Acceptance of Software (Due to Use of Existing Systems) Lack of Acceptance of Software (Competition from Commercial Systems) Implementation Ease Impact on Organizations (Shipyards) Distribution of Vendor Software Differences in Yard Practices (Non Computing) Difference in Technology Levels Among Different Yards (Non Computers) Difference in Mainframes Credibility of Navy Support Conversion and Overhaul (Different Users and Requirements) Competition in Shipyards Commitment to Hardware/Software (Differences) Claims Changing Views (Shipyard) Acceptance of Standards (Engineering vs. Computer) Acceptance of Computer Imposed Standards (Size of Data Field)		Integration Strategy Integration of Existing Software Inconsistent Functional Systems (Dev. Cycle and Impl.) Funding Instability Ensure Development of Maintainable/Readable Programs Difference in Minicomputers Contracting (Red Tape) ADP Policy (Procurement Problems HW/SW)

Table 5. Problems in Order of Severity

10.00 Contracting (Red Tape)
9.50 Funding Instability
9.00 Obtaining Authoritative Decisions from Shipyard Managers
8.80 Integration of Existing Software
8.66 Lead Time (Financial Funding)
8.16 Lack of Acceptance of Software (Due to Use of Existing Systems)
7.83 Staffing the CASDAC Project
7.50 ADP Policy (Procurement Problems HW/SW)
7.20 Portability of Data Base Management System
7.16 Marketing/Selling CASDAC
7.16 Integration Strategy
7.00 Ensure Development of Maintainable/Readable Programs
7.00 Maintenance Strategy
7.00 Commitment to Hardware/Software (Differences)
6.83 Navy Mangement (Higher Level)
6.83 Industry Management Attitudes
6.83 Impact on Organizations (Shipyards)
6.66 Lack of Acceptance of Software (Competition from Commercial Systems)
6.66 Difference in Mainframes
6.60 Implementation Ease
6.16 State of the Art Changing (Computer H/W)
6.16 Interface with Other EDP Systems
6.16 Difference in Minicomputers
5.83 Distribution of Vendor Software
5.33 Test and Evaluation
5.33 Short Term vs. Long Term Goals
5.00 Credibility of Navy Support
5.00 Inconsistent Functional Systems (Dev. Cycle Impl.)
4.83 Uncertainty of Shipyard Support
4.66 Computer Expertise in Industry
4.66 Claims
4.50 Lack of Shipyard Personnel
4.40 Responsiveness to Maintenance Modifications
4.33 Difference in Technology Levels Among Different Yards (Non-Computers)
4.33 Personnel Resistance
4.20 Competition in Shipyards
4.16 Differences in Yard Practices (Non-Computing)
4.00 Navy Relations with Other Programs
3.83 Changing Views (Shipyard)
3.80 Acceptance of Computer Imposed Standards (Size of Data Field)
3.66 Acceptance of Standards (Engineers vs. Computer)
3.66 Union (Contracts and Regulations)
3.60 Maintenance Cost
3.60 Unstable Shipyard Economy
3.50 Conversion and Overhaul (Different Users and Requirements)
3.00 Training of Shipyard Personnel
3.00 Physical Location of Shipyards

Table 6. Alternative Scores Based on Normalized Multipliers

		Alternatives										
		Use Machine Portable Code	Use Partially Portable Code (Specific Machines)	Develop CASDAC on One System (RJE Tw.in)	Develop CASDAC on Central System (RJE Tw.in)	Develop CASDAC on One System (Buy Machines for Shipyards)	Develop CASDAC on One System (Require Shipyards To Buy Machines)	Develop (Convert) Programs to Two or More Systems	Develop CASDAC on Commercially Available Network (Non Homogeneous)	Develop CASDAC on Commercially Available Network (Homogeneous)	Develop CASDAC in a Naval Shipyard for Use in Private Yards (Short Term)	Develop CASDAC in a Naval Shipyard for Use in Private Yards (Long Term)
Problems in Order of Severity												
10 00	Contracting (Red Tape)	-1	-1	+1	+1	+1	+1	-1	-1	-1	0	0
9 50	Funding Instability	0	0	0	0	0	0	0	0	0	0	0
9 00	Obtaining Authoritative Decisions from Shipyard Managers	+1	+1	0	0	+1	-1	+1	+1	0	+1	+1
8 80	Integration of Existing Software	0	-1	1	-1	-1	+1	-1	+1	1	0	1
8 66	Lead Time (Financial Funding)	0	-1	+1	+1	+1	+1	-1	-1	+1	0	0
8 16	Lack of Acceptance of Software (Due to Use of Existing Systems)	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	0
7 83	Staffing the CASDAC Project	1	-1	0	0	+1	+1	-1	-1	+1	0	0
7 50	ADP Policy (Procurement Problems HW/SW)	0	0	-1	-1	-1	0	+1	0	0	0	0
7 20	Portability of Data Base Management System	0	0	+1	+1	+1	+1	-1	-1	+1	0	0
7 16	Marketing/Selling CASDAC	+1	+1	+1	+1	+1	-1	+1	+1	+1	+1	+1
7 16	Integration Strategy	0	0	+1	+1	+1	+1	-1	0	0	0	0
7 00	Ensure Development of Maintainable/Readable Programs	0	0	-1	-1	+1	+1	-1	0	0	0	0
7 00	Maintenance Strategy	-1	+1	+1	+1	+1	+1	-1	-1	+1	+1	0
7 00	Commitment to Hardware/Software (Differences)	+1	+1	1	-1	-1	-1	+1	+1	-1	+1	0
6 83	Navy Management (Higher Level)	0	0	0	0	0	0	0	0	0	0	0
6 83	Industry Management Attitudes	+1	+1	0	0	+1	-1	+1	+1	+1	+1	+1
6 83	Impact on Organizations (Shipyards)	+1	+1	-1	-1	0	-1	+1	+1	-1	+1	0
6 66	Lack of Acceptance of Software (Competition from Commercial Systems)	0	0	0	0	+1	0	0	0	0	+1	0
6 66	Difference in Mainframes	+1	+1	+1	+1	+1	+1	+1	+1	-1	+1	0
6 60	Implementation Ease	-1	-1	+1	+1	+1	+1	+1	1	+1	+1	+1
6 16	State of the Art Changing (Computer H/W)	+1	-1	-1	-1	1	1	1	+1	1	0	1
6 16	Interface with Other EDP Systems	0	+1	-1	-1	+1	+1	1	+1	1	0	0
6 16	Difference in Minicomputers	+1	0	0	0	0	0	-1	+1	-1	0	0
5 83	Distribution of Vendor Software	0	0	+1	+1	+1	1	1	0	0	+1	0
5 33	Test and Evaluation	1	0	+1	+1	+1	+1	1	-1	+1	+1	+1
5 33	Short Term vs Long Term Goals	0	0	0	0	0	0	0	0	0	1	0
5 00	Credibility of Navy Support	0	+1	0	0	+1	+1	+1	+1	+1	+1	+1
5 00	Inconsistent Functional Systems (Dev Cycle and Impl)	0	+1	+1	+1	+1	+1	1	0	0	0	0
4 83	Uncertainty of Shipyard Support	+1	+1	0	0	+1	-1	+1	+1	-1	+1	+1
4 66	Computer Expertise in Industry	+1	0	+1	+1	+1	1	+1	1	0	+1	0
4 66	Claims	1	1	+1	+1	+1	1	1	1	1	+1	+1
4 50	Lack of Shipyard Personnel	0	0	0	0	0	-1	0	0	0	+1	0
4 40	Responsiveness to Maintenance Modifications	-1	+1	+1	+1	+1	+1	1	1	+1	+1	0
4 33	Difference in Technology Levels Among Different Yards (Non Computers)	0	0	0	0	0	0	0	0	0	+1	0
4 33	Personnel Resistance	0	0	0	0	0	0	0	0	0	0	0
4 20	Competition in Shipyards	0	0	0	0	0	0	0	1	0	+1	0
4 16	Differences in Yard Practices (Non Computing)	0	0	0	0	0	0	0	0	0	+1	0
4 00	Navy Relations with Other Programs	0	0	0	0	0	0	0	0	0	+1	+1
3 83	Changing Views (Shipyard)	0	0	0	0	0	0	0	0	0	+1	0
3 80	Acceptance of Computer Imposed Standards (Size of Data Field)	0	0	0	0	+1	0	0	0	0	+1	0
3 66	Acceptance of Standards (Engineering vs Computer)	0	0	0	0	0	0	0	0	0	+1	0
3 66	Union (Contracts and Regulations)	0	0	0	0	0	0	0	0	0	+1	0
3 60	Maintenance Cost	1	+1	+1	+1	+1	+1	1	1	+1	+1	0
3 60	Unstable Shipyard Economy	0	0	0	0	0	0	0	0	0	+1	0
3 50	Conversion and Overhaul (Different Users and Requirements)	+1	+1	+1	+1	+1	+1	+1	+1	0	+1	+1
3 00	Training of Shipyard Personnel	0	0	+1	+1	+1	-1	1	0	+1	+1	0
3 00	Physical Location of Shipyards	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	0
	Score	31	41	62	62	139	57	27	21	26	154*	42

+1 Problems Solved or Reduced
1 Problems Created or Increased
0 Problems Unaffected

*NOTE When eventual implementation in private shipyards is attempted the score of this alternative is reduced to that of Develop CASDAC in a Naval Shipyard (Long Term)

Table 7. Alternative Scores vs Various Multipliers

Alternatives	Multipliers: +1 Problems Solved or Reduced, -1 Problems Created or Increased, 0 Problems Unaffected	+2 Problems Solved or Reduced, -2 Problems Created or Increased, -1 Problems Unaffected	+3 Problems Solved or Reduced, -2 Problems Created or Increased, -1 Problems Unaffected	+3 Problems Solved or Reduced, -2 Problems Created or Increased, 0 Problems Unaffected
Use Machine Portable Code	31	-83	-3	141
Use Partially Portable Code (Specific Machines)	41	-43	51	177
Develop CASDAC on One System (RJE Tie-In)	62	12	124	236
Develop CASDAC on Central System (RJE Tie-In)	62	12	124	236
Develop CASDAC on One System (Buy Machines for Shipyards)	139	204	372	447
Develop CASDAC on One System (Require Shipyards to Buy Machines)	57	32	156	237
Develop (Convert) Programs to Two or More Systems	-27	-127	-40	32
Develop CASDAC on Commercially Available Network (Non-Homogeneous)	21	-61	34	137
Develop CASDAC on Commercially Available Network (Homogeneous)	26	-70	19	141
Develop CASDAC in a Naval Shipyard for Use in Private Yards (Short-Term)	154	200	359	468
Develop CASDAC in a Naval Shipyard for Use in Private Yards (Long-Term)	42	-117	-60	141

NOTE: When eventual implementation in private shipyards is attempted, the scores of this alternative are reduced to those of "Develop CASDAC in a Naval Shipyard (Long Term)"

APPENDIX - PROBLEMS UNAFFECTED OR RELATIVELY UNAFFECTED

Problems Unaffected by Alternatives Except Naval Shipyard Development (Short-Term Only):

Acceptance of Standards
(Engineering vs. Computer)

Differences in Yard Practices

Differences in Technology Among Yards

Unstable Shipyard Economy

Competition in Shipyards

Union Problems

Changing Views

Problems Unaffected by Alternatives Except Naval Shipyard Development (Long and Short Term):

Navy/MARAD Relations

Problems Unaffected by All Proposed Solutions:

Personnel Resistance

Funding Stability

Short-Term, Not Long-Term Goals

Navy Management

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